

**U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM**

SCIENTIFIC NAME: *Harrisia aboriginum*

COMMON NAME: Aboriginal pricklyapple or shellmound applecactus

LEAD REGION: 4

INFORMATION CURRENT AS OF: May 2010

STATUS/ACTION:

☐ Species assessment - determined species did not meet the definition of endangered or threatened under the Act and, therefore, was not elevated to Candidate status

☐ New candidate

☒ Continuing candidate

☒ Non-petitioned

☐ Petitioned - Date petition received:

☐ 90-day positive - FR date:

☐ 12-month warranted but precluded - FR date:

☐ Did the petition request a reclassification of a listed species?

☐ Listing priority change

Former LP: ____

New LP: ____

Date when the species first became a Candidate (as currently defined): September 12, 2006

☐ Candidate removal: Former LP: ____

☐ A - Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.

☐ U - Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.

☐ F - Range is no longer a U.S. territory.

☐ I - Insufficient information exists on biological vulnerability and threats to support listing.

☐ M - Taxon mistakenly included in past notice of review.

☐ N - Taxon may not meet the Act's definition of "species."

☐ X - Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Flowering plants, Cactaceae, Cactus Family

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Florida, U.S.A.

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Florida, Sarasota, Charlotte, Lee Counties, U.S.A.

LAND OWNERSHIP:

Plants occur on eight private properties, three of which are managed for conservation, and five that are not managed or protected. A ninth occurrence is located on private land that the owners claim is managed for conservation, but the owners have bulldozed some of the habitat at this site, so the validity of the protected status of this occurrence is in question. Plants occur at six publicly owned sites, four of which are managed as conservation areas, and two properties that are not (Bradley et al. 2004, p. 9-37; A. Nielsen, Florida Department of Environmental Protection (FDEP), pers. comm. 2009). The total occupied area of all sites is small, perhaps totaling 40.5 hectares (ha) (100 acres [ac]).

The known localities for this plant are (ownership shown in parentheses):

- **Private conservation lands:** Water Club Preserve on Longboat Key in City of Sarasota (The Water Club); Historic Spanish Point in Sarasota County (Gulf Coast Heritage Association, Inc.); Gasparilla Island in Charlotte and Lee Counties (Gasparilla Island Conservation and Improvement Association); portions of Buck Key (Sanibel Captiva Conservation Foundation).
- **Private non-conservation lands:** Cayo Pelau in Lee County; Guard House at North Manasota Key near Manasota Beach Park, a vacant lot and roadside portion of North Manasota Key occurrence in Sarasota County, portions of Buck Key. All of these are privately owned with unidentified owners.
- **Non-Federal public non-conservation lands:** Gasparilla Island Mosquito Ditch site in Lee County (Lee County); Kitchen Key in Charlotte County (Charlotte County).
- **Non-Federal public conservation lands:** Manasota Beach Park on North Manasota Key in Sarasota County (Sarasota County); Bogges Ridge and Big Mound on Cape Haze Peninsula at Charlotte Harbor Preserve State Park in Charlotte County (State); Bocilla Preserve on Bokeelia Island in Lee County (Lee County). The single plant on Cayo Costa Island on Cayo Costa State Park in Lee County died by 2008 (A. Nielsen, pers. comm. 2009).
- **Federal lands:** Buck Key on J.N. "Ding" Darling National Wildlife Refuge in Lee County (Service).

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BIOLOGICAL INFORMATION:

Species Description: Plants are erect to reclining, to 6 meters (20 feet) high (Ward 1979, p. 76; Anderson 2001, p. 370). Stems are simple or branching (Anderson 2001, p. 370) and cylindrical with 9-11 longitudinal ribs (Ward 1979, p. 76; Anderson 2001, p. 370). Areoles are spaced at 1-2 centimeter (cm) (0.4-0.8 inch [in]) intervals along the rounded crests of the ribs, each containing 10-15 long, dark-tipped spines (Ward 1979, p. 76). Needlelike spines are pink at first,

becoming gray with age, up to 1 cm (0.4 in) long (Anderson 2001, p. 370). Flowers are rather infrequent and widely spaced and each consists of a long, scaly tube, broadening to numerous green sepals, which are replaced by broader white petals (Ward 1979, p. 76). Flowers are up to 15 cm (5.9 in) long, slightly scented; floral tubes have stiff brown hairs (Anderson 2001, p. 370). Fruits are globose, 6-7.5 cm (2.4-3 in) in diameter, many-seeded, and yellow (to very rarely orange) when ripe (Anderson 2001, p. 370; Fellows et al. 2001, p. 1; A. Franck, University of South Florida, pers. comm. 2010).

Taxonomy: *Harrisia aboriginum* was described by John Kunkel Small after he discovered it on Terra Ceia Island in Manatee County in 1919. Small's name for this plant was published in a monograph of the cactus family by Britton and Rose (1920, p. 154). This name is still in use (Parfitt and Gibson 2004, p. 153; Wunderlin and Hansen 2008, p. 1-2), although possible alternative names for the species were proposed over the years. The following nomenclatural synonyms are cited in the Flora of North America (Parfitt and Gibson 2004, p. 153): *Cereus aboriginum* (Small ex Britton & Rose) Little, *C. gracilis* var. *aboriginus* (Small ex Britton & Rose) L. D. Benson, *Harrisia donae-antoniae* Hooten. Wunderlin and Hansen (2008, p. 3) indicate that *Harrisia gracilis* (Mill.) Britton var. *aboriginum* (Small ex Britton & Rose) D.B. Ward is a synonym.

Little (1945, p. 495) transferred this member of the genus *Harrisia* to the genus *Cereus*. He did not explain the rationale for this transfer in his nomenclatural note. Benson (1969, p. 126) published the scientific names (technically, combinations of existing names) needed to treat two of the prickly-apple cacti in southern Florida (*H. aboriginum* and *H. simpsonii*), as well as the similar *H. gracilis* in Jamaica, as a single species consisting of three varieties. Benson placed the *Harrisia* cacti within the genus *Cereus*, making the name for the aboriginal pricklyapple *Cereus gracilis* var. *aboriginum*. Austin's (1984, p. 69) comparisons showed that *H. aboriginum* and *H. simpsonii* are rather weakly distinct, but he treated them as distinct species, also within *Cereus*. Ward (2004, p. 365-371) published the new nomenclatural combination *Harrisia gracilis* (Mill.) Britton var. *aboriginum* (Small ex Britton & Rose) D. B. Ward. This was strictly a nomenclatural publication.

The generic placement of *H. aboriginum* and other Florida relatives has been in flux since they were first described, with some authors placing them in the large and variable genus *Cereus*, and other segregating them into the smaller *Harrisia* genus. Recent authors, including Hooten 1991, p. 64-66; Anderson 2001, p. 370; Ward 2004, p. 365-371; Parfitt and Gibson 2004, p. 150-153; Wunderlin and Hansen 2008, p. 1-2) have chosen to treat the Florida species in the genus *Harrisia*.

Hooten (1991, p. 64-66) published his opinion that an additional species of prickly-apple cactus should be recognized from Buck Island in coastal Lee County, based on plants whose flower buds had white hairs rather than brown. The name he provided, *H. donae-antoniae*, was not validly published because no specimen was cited (A. Franck, pers. comm. 2010). Other botanists consider that Hooten's plants represent *H. aboriginum* (Parfitt and Gibson 2004, p. 153; Wunderlin and Hansen 2008, p. 1-2). Thus, *H. aboriginum* includes plants on Buck Key that Hooten considered to represent a distinct species.

Finally, a book on the cactus family by Anderson (2001, p. 370) recognizes *Harrisia aboriginum*, but also includes *H. gracilis* of Jamaica in the Florida flora (with *Harrisia donae-antoniae* as a synonym), meaning that Anderson apparently considered Hooten's plants from Buck Key to be indistinguishable from similar plants from Jamaica. The Flora of North American (Parfitt and Gibson 2004, p. 150-153) recognizes *Harrisia aboriginum*, noting *Harrisia donae-antoniae* as "an invalid name for a local Florida variant of *H. aboriginum*."

The Regulated Plant Index of the Florida Department of Agriculture and Consumer Services (FDACS) is regularly reviewed by the Endangered Plant Advisory Council, whose members until recently included Daniel Austin (Florida Atlantic University) and Daniel B. Ward (University of Florida). The Regulated Plant Index comprises only full species, not intraspecific taxa. The Index includes *Harrisia gracilis*. Notes that are not part of the official Index explain that *Harrisia gracilis* includes *Harrisia aboriginum* from the Florida west coast and *Harrisia simpsonii* from the Florida east coast (Coile and Garland 2003, p. 26). The notes' unstated conclusion is that *H. aboriginum* can be considered a variety of *H. gracilis*, which would be consistent with the views of the systematists who were Council members.

The Integrated Taxonomic Information System (2010, p. 1) uses the name *Harrisia aboriginum* and indicates that this species' taxonomic standing is accepted. NatureServe (2009, p. 1) and the online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2008, p. 1-2) use the name *H. aboriginum*. Based upon the best available scientific information, *Harrisia aboriginum* Small ex Britton & Rose is a distinct taxon, endemic to the west coast of Florida. We have carefully reviewed the available taxonomic information to reach the conclusion that the species is a valid taxon.

The common name "aboriginal pricklyapples" is used by Bradley et al. (2004, p. 3). Wunderlin and Hansen (2008, p. 1) use "prickly applecactus" and "west coast prickly-apple." "Shellmound apple-cactus" was used by Little (1945, p. 495). Parfitt and Gibson (2004, p. 153) suggest "yellow prickly apple, aboriginal prickly apple, prickly applecactus."

Habitat: The species occurs on coastal berms and spoil mounds (Gann et al. 2002, p. 438), maritime hammocks, and shell middens (Ward 1979, p. 76; Coile and Garland 2003, p. 26). It is found at the edges of mangrove swamps and low thickets (Ward 1979, p. 76) and associated with the mangrove / hammock ecotone (Fellows et al. 2001, p. 3). Bradley et al. (2004, p. 3) stated that its typical habitats are shell mounds, coastal berms, coastal strand, maritime hammocks, and coastal grasslands. Data from the Florida Natural Areas Inventory (FNAI) (2007, p. 192-221) and Bradley et al. (2004, p. 3, 13, 16, 21) suggested that most of the occurrences are on coastal berms or coastal strand and many sites are disturbed. Interestingly, Small had named one of his plants "*aboriginum*" because of its growth on shell mounds created by the aboriginal Caloosas (Ward 1979, p. 76).

Bradley et al. (2004, p. 3, 10-36) indicated that the cactus occurs in coastal strand vegetation (relatively low salt-tolerant shrubs and grasses), tropical coastal hammocks with trees including gumbo limbo (*Bursera simaruba*), wild lime (*Zanthoxylum fagara*), or live oak (*Quercus virginiana*). Populations are likely to be on shell mounds created by pre-European local residents or at least on sites with shelly substrates. Plants may be quite close to the mangrove

zone, but not within it. A herbarium specimen at Fairchild Tropical Botanic Garden (Possley 29, collected 2001) from Buck Key states that the plant is, “rare in ecotone between coastal hammock and mangrove” in Lee County. Plants in maritime hammock and shell middens were observed growing in 50-75 percent shade canopy, and individual stems growing in full light appeared more yellow (possibly more stressed) than stems under shadier canopies (Fellows et al. 2001, p. 3), suggesting that the species may benefit from partial shade. Further site-specific information is provided below.

Historical Range/Distribution: Gann et al. (2002, p. 439) summarized the collecting history. The first collection was by A. S. Hitchcock in Lee County in 1900, as reported in a Service sponsored status survey by Austin et al. (1980, p. 139). A single collection was made in 1911 in Osprey in Sarasota County by John G. Webb (Bradley et al. 2004, p. 6). John Kunkel Small collected the plant on Terra Ceia Island, Manatee County in 1919; this is the type locality (New York Botanical Garden 2003, p. 1; Bradley et al. 2004, p. 4). In 1979, Daniel Austin and Sandra K. Austin collected this species on Buck Key, which is adjacent to Captiva Island. About the same time, Mark L. Hooten also collected plants from Buck Island and intended to describe them as a new species (as explained above under “taxonomy”). The survey by Morris and Miller (1981 as cited in Bradley et al. 2004, p. 3) reported aboriginal pricklyapple from four sites: Longboat Key, Manasota Key (2 sites), and Live Oak Key (Kitchen Key, just off of Gasparilla Island, not to be confused with a Kitchen Key in Manatee County). The four sites together had approximately 371 clumps of plants and all were privately owned (Morris and Miller 1981 as cited in Bradley et al. 2004, p. 3). In summary, the historical range of this species appears to have been from Terra Ceia Island south about 78 miles (125 kilometers [km]) to Buck Key.

Bradley et al. (2004, p. 6) stated, “There have been several erroneous reports of *H. aboriginum*. Lakela & Craighead (1965) reported it for Collier County. Long & Lakela (1976) reported it for the 10,000 Islands and the Florida Keys. Avery and Loope (1980) reported it for Everglades National Park, presumably based on the 10,000 Islands reference in Long & Lakela (1971). Hammer & Bradley (1998) and subsequently Stalter et al. (1999) reported it for Biscayne National Park in Miami-Dade County, where only *H. simpsonii* occurs. Austin et al. (1980) also discussed a specimen (Small s.n., NY) collected in St. Lucie County that had been annotated as *Cereus gracilis* var. *aboriginum* by Lyman Benson. This annotation seems to have been in error, since it was not reported for that county by Benson (1982). This was almost certainly a specimen of *H. fragrans*.”

Current Range/Distribution: The status survey by Bradley et al. (2004, p. 4-5) included an examination of the available literature and herbarium specimens and consultation with knowledgeable field biologists. Bradley et al. (2004, p. 5) visited 16 properties from Terra Ceia Island south to Delnor Wiggins State Park. The species was determined to be extirpated in part of its historical range. The type locality, Terra Ceia Island, no longer contains any plants, and the species was not found in Manatee County, where it formerly occurred (Bradley et al. 2004, p. 4, 8-9). The State reported that the single plant occurrence on Cayo Costa Island, within Cayo Costa State Park, Lee County (owned by the State of Florida) has also been extirpated (A. Nielsen, pers. comm. 2009).

The Bradley et al. (2004, p. 8) status survey confirmed 10 extant occurrences along a 62 mile

(100 km) stretch of coast. No new occurrences were reported in the past year, but one (Cayo Costa) was reported as extirpated in 2009 (A. Nielsen, pers. comm. 2009). Currently there are nine remaining extant occurrences:

- Water Club Preserve, Longboat Key, Sarasota County (4 acre [1.6 ha] private conservation area).
- Historic Spanish Point, Sarasota County (small conservation area owned by the Gulf Coast Heritage Association, Inc., a nonprofit organization).
- North Manasota Key, Sarasota County (including Manasota Beach Park, the guard house at the entrance to a private community, a vacant lot, and a roadside).
- Charlotte Harbor Preserve State Park (formerly Charlotte Harbor State Buffer Preserve), southern Cape Haze Peninsula, Charlotte County (Bogges Ridge and Big Mound) (owned by the State of Florida).
- Kitchen Key (also known as Live Oak Key), a peninsula attached to Gasparilla Island, 0.9 mile (1.5 km) from the northern end of the island, and south of the causeway from the mainland (owned by Charlotte County). This includes a tract owned by the Gasparilla Island Conservation and Improvement Association.
- Cayo Pelau, Lee County (privately owned).
- Gasparilla Island Mosquito Ditch site (owned by Lee County, not a conservation area).
- Bocilla Preserve, Bokeelia Island (owned by Lee County).
- Buck Key, J.N. "Ding" Darling National Wildlife Refuge, Lee County (owned by Service).

The survey provided exact locations of all clumps of plants. The areas they occupy are quite small, totaling perhaps <40.5 ha (100 ac), depending on how generously one draws lines around shell mounds in larger preserves on conservation lands. The surveyors asked many individuals familiar with the coast about possible sites and used up-to-date aerial imagery and made use of previous surveys. Due to coastal development, there is little possibility of more than a few additional plants being found in Sarasota or Manatee Counties. The islands and wetlands near the entrance to Charlotte Harbor are difficult to access, so it is impossible to exclude the possibility of finding additional plants. However, the larger shell mounds and other upland areas are identifiable from aerial photographs and have been visited fairly often. The main prospect for additional locations of the cactus may be from the vicinity of Marco Island southward, including the Ten Thousand Islands, which are primarily mangrove, but have small uplands with hardwoods and several Pre-Columbian sites. Ten Thousand Islands National Wildlife Refuge has not had a thorough survey of its flora. Additionally, parts of coastal Everglades National Park are remote, and we cannot exclude the possibility that the cactus occurs there. It is, however, extremely unlikely that the species is present in better explored areas, from Flamingo in Everglades National Park eastward on the mainland or in the Florida Keys.

Population Estimates/Status: Data below are from Bradley et al. (2004, p. 10-37) with summary of threats (more detail on threats follows).

Location	Total # (Groups)	Threats
1) Water Club Preserve	5 plants (3 groups)	Development, exotic plants, and fire suppression
2) Historic Spanish Point	2 plants (1 group)	Disturbance and exotics

3) North Manasota Key	125 plants (5 groups)	Habitat destruction, wildfire, dumping, exotic plants, development
4) Charlotte Harbor Preserve State Park	39 plants (2 groups)	Disturbance, sea level rise, exotic plants
5) Kitchen Key	< 10 plants (1 group)	Sea level rise, exotic plants
6) Cayo Pelau	7 plants (1 group)	Sea level rise, development, exotic plants
7) Gasparilla Island	2 plants (2 groups)	Sea level rise, stochastic events, exotic plants and animals
8) Bocilla Preserve	several hundred plants (6 groups)	Sea level rise, exotic plants
9) Buck Key	100-200 plants (1 group)	Development

- 1) Water Club Preserve. Five plants in three groups. This is part of a residential community and has no formal protection; one area had been bulldozed. Invasive exotic plants such as Brazilian pepper (*Schinus terebinthifolius*) threaten the area and fire suppression is a threat.
- 2) Historic Spanish Point. Two adult plants on a shell mound. The site is very disturbed. Plants are threatened by nearby exotics, including asparagus fern (*Asparagus densiflorus*), bowstring hemp (*Sansevieria hyacinthoides*), and a cactus (*Hylocereus undatus*).
- 3) North Manasota Key.
 - o Manasota Beach Park. Two groups of plants. The northern group consists of 100 plants. The southern grouping consists of three plants. The coastal strand vegetation is relatively intact. Plants are threatened by human activity such as wildfires, dumping, and local habitat destruction (from aggressive use), and exotic plants, such as Madagascar periwinkle (*Catharanthus roseus*), Brazilian pepper, an introduced cactus (*Selenicereus pteranthus*), and St. Augustine grass (*Stenotaphrum secundatum*).
 - o Guard house at the entrance to a private community, adjoining the Manasota Beach Park. Two plants. Their status is precarious; at the time of the survey, mulch was being spread for landscaping purposes. Brazilian pepper is also encroaching.
 - o Vacant lot. Nineteen plants. Plants are severely threatened by development; this is one of the last undeveloped lots on this barrier island. Plants are also threatened by exotics such as *Hylocereus undatus*, Brazilian pepper, St. Augustine grass, and Caribbean trumpet-tree (*Tabebuia aurea*).
 - o Roadside near northern terminus of road. One plant. Located in shady coastal berm / maritime hammock vegetation. The plant is threatened by development and road widening.
- 4) Charlotte Harbor Preserve State Park.
 - o Boggess Ridge. Disturbed coastal berm with 36 plants. Threats include human disturbance from boaters landing on the ridge, sea-level rise, and exotics.
 - o Big Mound. Three plants on 8 ha (20 ac) shell mound with tropical trees and shrubs. The cactus has been known from this site since 1981, when it was observed by Morris and Miller. Human disturbance and exotic plants are threats.
- 5) Kitchen Key, also known as Live Oak Key. Fewer than 10 plants, on coastal berm with live oak and cabbage palm (*Sabal palmetto*). This area is owned by Charlotte County, but is not managed for conservation purposes. Plants are threatened by present and future sea level rise;

cabbage palms are dying, probably due to excessive salinity. Exotic plants, especially Brazilian pepper, are a threat. This site was hit by Hurricane Charley.

- 6) Cayo Pelau. Seven plants found on a low shell mound with coastal strand and coastal hammock plants; occurrence seems to be declining based upon several dead and dying plants; Plants located within a few meters from high tide line. Plants appear to be threatened by sea-level rise, development, and exotics such as Brazilian pepper and Australian pine (*Casuarina equisetifolia*).
- 7) Gasparilla Island.
 - o Conservation and Improvement Association Tract A, Lee County. One plant on a thin upland strip along tidal swamp shoreline. This site is a short distance south of Kitchen Key and the plant is probably a vegetative recruit from plants on Kitchen Key. Plant is threatened by sea level rise, exotic plants, and stochastic events.
 - o Mosquito Ditch site. One large plant or occurrence (approximately 500 stems, with the tallest stem about 8.2 feet [2.5 m] tall) on shell spoil from a mosquito-control ditch. This occurrence is threatened by both exotic plants (Brazilian pepper, Australian pine) and exotic animals (introduced iguanas), which consume flowers.
- 8) Bocilla Preserve, Bokeelia Island. Six groups of plants comprising several hundred individual plants are on a coastal berm surrounded by tidal swamp. Plants appear to be threatened by sea level rise and exotics such as Brazilian pepper and Australian pine. The site is owned by Lee County, but is not managed for conservation purposes.
- 9) Buck Key, J.N. "Ding" Darling National Wildlife Refuge and Sanibel-Captiva Conservation Foundation conservation lands, and a private owner. Richard Workman reported 100 to 200 individual plants in 2000. Several dozen plants were observed and mapped by IRC and Fairchild Tropical Botanic Garden in 2001. Most of the plants are on land owned by the Service. Private portions of Buck Key are likely to be developed, resulting in loss of that portion of the occurrence.

Bradley and Woodmansee (2004, p. 1) estimated only 350-400 plants exist in the wild. Woodmansee et al. (2007, p. 87) suggested similar numbers, estimating roughly 300-500 plants in 2006. FNAI (2010a, p. 10, 2010b, p. 5) considers the global status of the aboriginal pricklyapple to be G1, critically imperiled. Similarly, NatureServe (2009, p. 1) considers the rounded global status to be G1, critically imperiled. The species is listed as endangered by the Florida Department of Agriculture and Consumer Services (FDACS).

THREATS:

- A. The present or threatened destruction, modification, or curtailment of its habitat or range.
The coastal habitats that this species inhabits have been heavily impacted by development (Bradley et al. 2004, p. 3). Shell mounds, created by American Indians, were among the first areas colonized by early Western Europeans because of their high elevations and were later used extensively for construction material, resulting in their destruction (Bradley et al. 2004, p. 3). Because of their proximity to the beach and higher elevations, coastal hammocks, strands, and berms were also used for coastal residential construction (Bradley et al. 2004). As a result, this species has been extirpated from part of its historic range and only isolated fragments of suitable habitat remain (Bradley et al. 2004, p. 3-4).

Several of the occurrences remaining are currently threatened by development (Bradley et al. 2004, p. 3-37; FNAI 2007, p. 192-221; NatureServe 2009, p. 1), and all habitat for the aboriginal pricklyapple on private land is threatened by destruction (Bradley et al. 2004, p. 6). At Water Club Preserve (5 plants), Longboat Key, one part of the four-acre “conservation area” in this development has been bulldozed (Bradley et al. 2004, p. 10-12). This site is called a “conservation area”, but it is part of a development and the aboriginal pricklyapple may not be protected at this site (Bradley et al. 2004, p. 10-12). A post-hurricane assessment survey at Water Club Preserve reported no change in the plant population size since the 2004 hurricane season (Woodmansee et al. 2007, p. 85). The occurrence on North Manasota Key is threatened by various forms of habitat loss: the vacant Gulf-front lot, which supports 19 plants, is severely threatened by development (Bradley et al. 2004, p. 18; FNAI 2007, p. 214); one plant along a roadside is threatened by road widening and development; and two plants at the guard house at the entrance to a private community are threatened by landscaping work (Bradley et al. 2004, p. 16-17, 19-20; FNAI 2007, p. 192, 212). In addition, the occurrence on Buck Key (several dozen plants) is partially at risk since private portions of that Key are likely to be developed (Bradley et al. 2004, p. 36-37).

Loss and modification of coastal habitat is expected to continue and increase. Charlotte and Lee Counties, where this plant occurs, are expected to build out before 2060 (Zwick and Carr 2006, p. 13). Occurrences on private land or non-conservation public land (i.e., parts of residential developments, vacant lot, roadsides, mosquito ditch) are currently at-risk; threats of habitat loss, modification, and degradation are expected to increase with increased human population, development pressure, and infrastructure needs.

Climatic changes and sea level rise are major threats to south Florida, including this species and its habitat. The possible effects of sea level rise on Kitchen Key were noted in the 1980s, and recent deaths of cabbage palms at this location suggest that this is a continuing threat (Bradley et al. 2004, p. 7). Most occurrences of the aboriginal pricklyapple are located just slightly above mean sea level, and the effects of sea level rise are expected to be a continual problem for this species and its habitat (Bradley et al. 2004, p. 7). The Intergovernmental Panel on Climate Change (IPCC) reported that the warming of the world’s climate system is unequivocal based on documented increases in global average air and ocean temperatures, unprecedented melting of snow and ice, and rising average sea level (IPCC 2007, p. 2; 2008, p. 15). Sea-level rise is the largest climate-driven challenge to low-lying coastal areas and refuges in the sub-tropical ecoregion of southern Florida (U.S. Climate Change Science Program [CCSP] 2008, p. 5-31, 5-32).

IPCC (2008, p. 28) emphasized it is very likely that the average rate of sea-level rise during the 21st century will exceed that from 1961 to 2003 (i.e., 0.071 inches [0.18 cm] per year), although it was projected to have substantial geographical variability. Partial loss of the Greenland and/or Antarctic ice sheets could result in many feet (several meters) of sea-level rise, major changes in coastlines, and inundation of low-lying areas (IPCC 2008, p. 28-29). Low lying islands and river deltas will incur the largest impacts (IPCC 2008, p. 28-29). Because dynamic ice flow processes in ice sheets are poorly understood, timeframes are not known; however, modeling indicates that “more rapid sea-level rise on century timescales cannot be excluded” (IPCC 2008, p. 29). According to CCSP (2008, p. 5-31), much of low-

lying, coastal south Florida “will be underwater or inundated with salt water in the coming century”.

IPCC (2008, p. 3, 103) concluded that “climate change is likely to increase the occurrence of saltwater intrusion into coastal aquifers as sea level rises” and that “sea-level rise is projected to extend areas of salinisation of groundwater and estuaries, resulting in a decrease of freshwater availability for humans and ecosystems in coastal areas”. From the 1930s to 1950s, increased salinity of coastal waters contributed to the decline of cabbage palm forests in southwest Florida (Williams et al. 1999, p. 2056-2059), expansion of mangroves into adjacent marshes in the Everglades (Ross et al. 2000, p. 9, 12-13), and loss of pine rockland in the Keys (Ross et al. 1994, p. 144, 151-155). Hydrology has a strong influence on plant distribution in these and other coastal areas (IPCC 2008, p. 57). Such communities typically grade from salt to brackish to freshwater species. Human developments will also likely be significant factors influencing whether natural communities can move and persist (IPCC 2008, p. 57; CCSP 2008, p. 7-6).

Climatic change and sea level rise are expected to significantly affect the aboriginal pricklyapple (Fellows et al. 2001, p. 4). Each of the remaining occurrences is threatened by sea level rise (Bradley et al. 2004, p. 6; FNAI 2007, p. 202, 216, 218, 220). Since all occurrences are slightly above mean sea level, this will be a continuing problem for the species (Bradley et al. 2004, p. 7). Therefore, present and future sea level rise is a threat.

In summary, all occurrences are at risk to habitat loss and modification. Extant occurrences on private land are threatened by development. We find the magnitude of this threat to be high and imminent. Overall threat level of habitat loss from development is high, because four of the nine occurrences are vulnerable. All occurrences are in low-lying areas and will be affected by rising sea level. We find the magnitude of the threat from sea level rise to be high and imminent, however the overall threat level from sea level rise is expected to become severe in the future.

- B. Overutilization for commercial, recreational, scientific, or educational purposes. Cacti are vulnerable to collection. Members of the genus *Harrisia* are collectible; they have impressive night-blooming flowers and are on display at facilities such as the Royal Botanic Gardens. NatureServe (2009 p. 1) indicates that this species is threatened by horticultural collection. Bradley et al. (2004, p. 6) stated that each of the remaining occurrences is threatened by poaching. However, at this time, we do not know to what extent this is occurring. We find that the magnitude of this threat is moderate and imminent.
- C. Disease or predation. Non-native iguanas have been observed to eat flowers of aboriginal pricklyapple at the Gasparilla Island mosquito ditch site. Iguanas are an emerging problem in the Florida Keys and the Miami urban area, but only anecdotal information is available on their abundance or potential to be damaging. Thus, even though iguanas have been observed eating flowers of the cactus, we do not have adequate information on whether they constitute a serious threat. Scale insects have been observed as herbivores in some aboriginal pricklyapple populations, occasionally causing severe damage to plants (K. Bradley, pers. comm. 2005). FNAI (2007, p. 216) indicated that large specimens at the Boggess Ridge Site

were in fruit and many fruits had holes where the seeds were eaten, presumably by birds. Bradley et al. (2004, p. 10) noted what appeared to be evidence of herbivory, possibly by snails, at the Water Club Preserve site.

Cactus rot, a disease which could be due to a number of causes, has been observed to kill aboriginal pricklyapple (Austin 1984, p. 69; K. Bradley, pers. comm. 2005). With this disease, the base of the plant begins to die with rot progressing from the base to the tips of the stems, eventually killing the plant. At this time, we do not know to what extent the species is threatened by disease or predation; however, both are potential threats given the species' few occurrences and small population size.

In summary, disease and predation are a threat to aboriginal pricklyapple. We find that the magnitude of this threat is moderate, and we believe it to be imminent. Herbivory by iguanas, scale insects, and birds may eventually affect all populations, but currently the overall level of these threats is unknown. The causes of cactus rot are unknown. This disease may affect all populations, but currently the overall level of this threat is unknown.

- D. The inadequacy of existing regulatory mechanisms. The aboriginal pricklyapple is State listed as endangered. FDACS uses different botanical nomenclature from the Service, designating all of *Harrisia gracilis* (including *Harrisia aboriginum* as well as the relatively more widespread *H. simpsonii*) as endangered under Chapter 5B-40, Florida Administrative Code (see discussion under Taxonomy). This listing provides little or no habitat protection beyond the State's Development of Regional Impact process, which serves to disclose impacts from projects, but provides no regulatory protection on private lands. Without local or county ordinances preventing the destruction of the plant, conservation does not occur. So far, there has been relatively little interest in protecting native vegetation on private land or encouraging or requiring the use of native plants in landscaping on the barrier islands. However, effective programs exist to encourage restoration of native vegetation and use of native landscaping on public conservation and recreation lands.

In summary, the inadequacy of existing regulatory mechanisms is a threat to aboriginal pricklyapple of moderate magnitude. We find that this threat is imminent. Existing regulations do not adequately protect the occurrences on State or private lands from habitat destruction or modification. The overall level of threat is moderate.

- E. Other natural or manmade factors affecting its continued existence. The spread of Brazilian pepper and Australian pine, both nonnative species, has greatly altered coastal vegetation. Herwitz et al. (1996, p. 705-715) showed that on Cayo Costa, the coastal strand habitat had experienced dramatic increases in Australian pine between 1975-1977 and 1990-1992, and that Brazilian pepper had spread dramatically in other habitats, and had become a dominant woody species. They concluded that expanding populations of these species "appear to be closely related to the decrease in species number and the reduced population sizes of many resident species." Brazilian pepper tends to form shaded single-species stands. Australian pine, a tall tree producing deep shade and abundant litter, appears to kill native plants through allelopathy (suppression of growth of a plant by a toxin released from a nearby plant of the same or another species), forming single-species stands and excluding essentially all

native species. The aboriginal pricklyapple requires at least partially open conditions, and is not observed in thickets. Bradley et al. (2004, p. 6) stated that each of the remaining occurrences of the aboriginal pricklyapple is threatened by exotic plants. Similarly, FNAI (2007, p. 192-221) and NatureServe (2009, p. 1) identified encroachment of exotic plants as a threat to this species. In addition, due to the species' requirement for fairly open conditions and sunlight, excessive shading due to fire suppression is also considered a threat (Bradley et al. 2004, p. 10-11; NatureServe 2009, p. 1); however it may only be localized.

Few occurrences appear to be viable (Fellows et al. 2001, p. 5). Of the remaining occurrences, five are comprised of less than 10 individuals, two are comprised of less than 50, and the other two may have a hundred or more plants (Bradley et al. 2004, p. 3-37). Since there are only nine extant occurrences with a maximum of 500 plants, the loss of a single occurrence, or even the significant decline of any occurrence, is significant (Bradley and Woodmansee 2004, p. 1; Woodmansee et al. 2007, p. 87). According to the Conservation Action Plan for this species, viable occurrences may still lack the necessary genetic diversity to be sustainable on a 50-year time scale (Fellows et al. 2001, p. 5). This plan suggests that introduction attempts in appropriate mainland habitats could forestall some of the effects of sea level rise and increase dispersal to new and appropriate locations. The small sizes of existing occurrences exacerbate the risk of local extirpation, even though individual plants spread vegetatively and may be relatively long-lived. In addition, small population sizes make the species more vulnerable to stochastic events.

Of these stochastic events, the most serious are hurricanes and tropical storms. Hurricanes and tropical storms are a regular feature of this coast's climate and a threat to the remaining occurrences of this species. In 2004, Hurricane Charley, a Category 4 hurricane, crossed the coastal areas of Lee and Charlotte Counties making landfall on Cayo Costa Island (Bradley and Woodmansee 2004, p. 1) and passed within 8 km (5 miles) of seven occurrences and within 29 km (18 miles) of all occurrences (Bradley and Woodmansee 2004, p. 1). The State reported that the occurrence on Cape Haze peninsula in Charlotte Harbor Preserve State Park (Bogges Ridge), visited in 2006 for the first time since Hurricane Charley, was in poor condition (A. Nielsen, pers. comm. 2007). Nielsen (pers. comm. 2007) reported that the occurrence has been mangled by fallen limbs and desiccated by the sudden increase in sun exposure when the canopy was opened. Woodmansee et al. (2007, p. 85) assessed damage as severe at Big Mound (much of the tree canopy damaged, many trees broken or knocked down) and moderate to severe at Bogges Ridge and Bocilla Preserve (similar damage to a lesser extent). Plants damaged by Hurricane Charley in 2004 have recovered and seem to be thriving at Bogges Ridge and Big Mound Key (A. Nielsen, pers. comm. 2009). Damage was moderate at Historic Spanish Point (broken limbs of canopy trees) and low at Cayo Pelau Preserve, Manasota Beach Park, and North Manasota Key Private Lot #1 (Woodmansee et al. 2007, p. 85). No habitat damage was observed at North Manasota Key Private Lot #2, Water Club Preserve, or Cayo Costa State Park (Woodmansee et al. 2007, p. 85), although the single plant located on Cayo Costa had died by mid-2008 as a result of damage from Hurricane Charley (A. Nielsen, pers. comm. 2009).

Hurricanes and tropical storms can modify habitat (e.g., through storm surge) and have the potential to destroy entire occurrences. In the case of Hurricane Charley, the aboriginal

pricklyapple was negatively impacted initially in the form of mortality, plant breakage, and occurrence reduction (Woodmansee et al. 2007, p. 115). Woodmansee et al. (2007, p. 85) found that hurricane damage to plants at all (10) sites ranged from none to moderate-severe and consisted of only slight breakage combined with rot or only slight breakage. Only one site (Bogges Ridge) had direct evidence of reduction (i.e., dead plants) as a result of impacts from Hurricane Charley; however, indirect evidence of general declines at three sites suggests that there was additional hurricane damage resulting in further mortality (Woodmansee et al. 2007, p. 85). Damage to plants at Bocilla Preserve occurred due to a tree fall two years post-hurricane (Woodmansee et al. 2007, p. 85). Hurricane damage to the single plant on Cayo Costa led to the extirpation of the species from this locality (A. Nielsen, pers. comm. 2009). Overall, occurrence size since Hurricane Charley was reduced at four sites, unchanged at five sites, and increased at one site (Woodmansee et al. 2007, p. 85; A. Nielsen, pers. comm. 2009). However, over the long-term hurricanes can be beneficial to the species by opening up tree canopies allowing some light to penetrate, thereby possibly creating the necessary conditions for growth (Woodmansee et al. 2007, p. 115).

In summary, aboriginal pricklyapple is vulnerable to a wide array of other natural and human factors, including: fire suppression, exotic plants, road widening, hurricanes and extreme weather events, storm surges, small number of occurrences, small and isolated occurrences, and restricted range. We find collectively that these are imminent threats of high magnitude, resulting in high or severe overall threat levels individually.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED

There is a Conservation Action Plan for the aboriginal pricklyapple (Fellows et al. 2001, p. 1-6). Although the plan was written prior to the work by Bradley et al. (2004, p. 1-40) and is somewhat outdated, it provides useful information and outlines potential management options (e.g., establish recovery objectives, augmentation, introduction, introduction at restored sites).

Land acquisition by public agencies, including the Service, has protected some occurrences from development. The public land managers within this species' range, including J. N. "Ding" Darling National Wildlife Refuge, have made efforts to control Australian pine, Brazilian pepper, and other exotic plants.

Fairchild Tropical Botanical Garden has plant material, and Sanibel Captiva Conservation Foundation has a limited number of individuals that have been used in an outplanting attempt (Fellows et al. 2001, p. 4). One augmentation attempt has been made and one introduction attempt is ongoing (both by the Sanibel-Captiva Conservation Foundation) (Fellows et al. 2001, p. 5). In addition, Fairchild Tropical Botanical Garden created satellite maps with UTM locations for populations (Maschinski et al. 2002, p. 8).

SUMMARY OF THREATS

The species has lost the majority of its former habitat in coastal areas throughout its historical range, comprised of three counties in southwest Florida. Only nine occurrences of this species remain, and most are small and vulnerable to a wide array of threats (Bradley et al. 2004, p. 3-37). Occurrences on private lands are threatened by habitat destruction (Bradley et al. 2004, p. 6). Each occurrence, on private or public land, faces numerous threats, including exotic plant

encroachment, poaching, and sea level rise (Bradley et al. 2004, p. 6). Although threats from exotic species can be partially addressed through active management, the threat of sea level rise will be continually problematic, since all occurrences are slightly above mean sea level (Bradley et al. 2004, p. 6). Climatic changes and sea level rise are long-term threats that will continue; these factors are expected to continue to impact coastal south Florida and ultimately reduce the extent of available habitat. All sites are vulnerable to hurricanes. There appears to be few viable occurrences remaining, and these may still lack the necessary genetic diversity to be sustainable on a 50-year time scale (Fellows et al. 2001, p. 5). Small populations are inherently vulnerable to stochastic events. With limited occurrences remaining and a maximum of 500 plants, the loss of a single occurrence or even the significant decline of any occurrence, is significant [to the species as a whole] (Bradley and Woodmansee 2004, p. 1; Woodmansee et al. 2007, p. 87). We find that this species is warranted for listing throughout all its range, and, therefore, find that it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

RECOMMENDED CONSERVATION MEASURES

- Acquire or protect private lands that support the aboriginal pricklyapple (Bradley et al. 2004, p. 7). Use conservation agreements with willing landowners where acquisition is not possible.
- Consider reintroduction to Terra Ceia Island at Madira Bickel State Archaeological Site (Bradley et al. 2004, p. 7). This site does not have sufficient area to sustain a large population, but its elevation is high and it is the northernmost locality known for the species (Bradley et al. 2004, p. 7).
- Monitor all occurrences on an annual basis (Woodmansee et al. 2007, p. 115).
- Survey Kitchen Key, Buck Key, Casperson Beach, and other sites to determine presence following storms (Woodmansee et al. 2007, p. 115).
- Investigate other shell mounds, archeological sites, and coastal sites that provide suitable habitat for opportunities for reintroduction within the species' historical range.
- Attempt re-introduction at Cayo Costa, which had only a single plant (Bradley et al. 2004, p. 7) until it died as a result of damage caused by Hurricane Charley (A. Nielsen, pers. comm. 2009).
- Investigate reintroduction at appropriate mainland habitats, which could forestall some effects of sea level rise and increase dispersal to new and appropriate locations (Fellows et al. 2001, p. 5). The occurrences, which are just 62 miles (100 km) apart (Bradley et al. 2004, p. 6), could be severely affected by a single hurricane or tropical storm; reintroduction could increase this range and decrease the probability of storm damage to the entire species (Fellows et al. 2001, p. 5-6).
- Address factors such as invasive plant and animal management, poaching, and sea level rise within management plans at all conservation lands where this species occurs (Bradley et al. 2004, p. 7; Woodmansee et al. 2007, p. 115).
- Continue work to control invasive plant species on public sites and with private landowners (Woodmansee et al. 2007, p. 115).
- Restore available land at highly disturbed coastal sites to native vegetation, including this species where appropriate (Fellows et al. 2001, p. 6). This could increase the number of populations without affecting the functioning of natural areas that do not currently provide habitat to this species (Fellows et al. 2001, p. 6).

- Reduce canopy in areas where shading is a problem (Woodmansee et al. 2007, p. 115).
- Implement careful fire management in fire adapted habitats surrounding populations so as to not negatively impact this species (Woodmansee et al. 2007, p. 115).
- Conduct additional study on the potential for outplanting (Fellows et al. 2001, p. 6).
- Conduct studies to determine current level of genetic variation remaining in extant occurrences.

LISTING PRIORITY

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2*
	Non-imminent	Subspecies/population	3
		Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
	Non-imminent	Subspecies/population	9
		Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude: Only nine occurrences of this species remain with a maximum of 500 plants total, and most occurrences are small and vulnerable to a wide array of threats (Bradley et al. 2004, p. 3-37, Bradley and Woodmansee 2004, p. 1; Woodmansee et al. 2007, p. 87; A. Nielsen, pers. comm. 2009). Occurrences on private lands are threatened by habitat destruction (Bradley et al. 2004, p. 6). Each occurrence, on private or public land, faces threats of exotic plant encroachment, poaching, and sea level rise (Bradley et al. 2004, p. 6). The magnitude of these threats is high. The threat from exotic species can be partially addressed through active management; this threat has been partially reduced on publicly-owned conservation lands, including Buck Key, which supports a larger occurrence. However, the threat of sea level rise is substantial and more difficult to address; it is expected to be continually problematic, since all occurrences are slightly above mean sea level (Bradley et al. 2004, p. 6). Proximity to the coast, combined with restricted range, few occurrences, and small number of plants in each occurrence, makes the species vulnerable to hurricanes and tropical storms. The magnitude of these threats is high. Predation and disease are considered to be threats of moderate to low magnitude. Predation by introduced iguanas appears to be a problem at one small occurrence, but we do not know the extent to which this threat may impact the species. Poaching is considered a threat of moderate to low magnitude. Overall, the magnitude of threats is high.

Imminence: Few occurrences remain and few or possibly only one may be viable (Fellows et al. 2001, p. 5). Occurrences are on private land and are currently threatened by habitat loss (Bradley et al. 2004, p. 6). One occurrence is on one of the last vacant lots on a barrier island. The largest occurrence may be impacted by development of private land adjacent to the Ding Darling National Wildlife Refuge on Buck Key. All occurrences are currently threatened by exotic plant encroachment and potential poaching (Bradley et al. 2004, p. 6). The long-term effects of sea level rise will threaten all sites. Sea level rise is thought to be impacting one site (Kitchen Key). The current occurrences, which are just 62 miles (100 km) apart (Bradley et al. 2004, p. 6), could be severely affected by a single hurricane or tropical storm (Fellows et al. 2001, p. 5). Predation and disease are not considered to be imminent threats. Overall, the immediacy of threats is imminent.

Yes Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed?

Is Emergency Listing Warranted? No. We do not believe that emergency listing is warranted at this time. However, the status of this species must be followed closely. The aboriginal pricklyapple has continued to persist, albeit in small numbers in few occurrences; however, there may only be one viable occurrence remaining. The status and distribution of the species needs to be monitored closely to detect change and any further decline. The loss of a single occurrence or even the decline of any occurrences would be detrimental to the status of the species. The Service and its partners need to implement actions to conserve this species, remove threats, and increase viability wherever possible.

DESCRIPTION OF MONITORING: The Service funded IRC to conduct a rangewide status survey in 2004 and post-hurricane field assessment in 2005. Bradley et al. (2004, p. 1-40) provided site-specific information on threats and made recommendations for conservation of the species. Woodmansee et al. (2007, p. 79-116) provided a detailed assessment of the status of the species after Hurricane Charley. This species is not being actively monitored. Monitoring of occurrences is recommended; at a minimum, monitoring should be conducted on an annual basis (Woodmansee et al. 2007, p. 115).

COORDINATION WITH STATES:

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment: The Service requested new information (observations, data, reports) regarding the status of this plant or any new information regarding threats to this species from: FDACS, National Park Service, Service (National Wildlife Refuges), FDEP, Miami-Dade County, Florida Fish and Wildlife Commission, FNAI, IRC, Historic Bok Sanctuary, The Nature Conservancy, Fairchild Tropical Botanic Garden, Archbold Biological Station, NatureServe, Miami University, University of Central Florida, Florida International University, University of Florida, Princeton, members of the Rare Plant Task Force, botanists, and others. In total, the previous assessment was sent to approximately 200 individuals.

The State of Florida does not include plants in their State Wildlife Action plan.

Indicate which State(s) did not provide any information or comments: None.

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APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve:  June 15, 2010
for Regional Director, Fish and Wildlife Service Date

Concur: _____
Director, Fish and Wildlife Service Date

Do not concur: _____
Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review: May 16, 2010

Conducted by: Paula Halupa, South Florida Ecological Services Office